SUBSTRATE TREATMENT APPARATUS

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This U.S. non-provisional patent application claims priority under 35 U.S.C. §119 to Korean Patent Application No. 10-2015-0144114, filed on Oct. 15, 2015, in the Korean intellectual Property Office, the entire contents of which are hereby incorporated by reference.

BACKGROUND OF THE INVENTION

[0002] The present disclosure relates to substrate treatment apparatuses, and in particular, to substrate treatment apparatuses configured to supply one or more additional control gases into an exhausting line of the substrate treatment apparatus and to control an internal pressure of a process chamber of the substrate treatment apparatus.

[0003] In some cases, semiconductor devices may be fabricated using a plurality of unit processes, including a deposition process or an etching process, an ion implantation process, and a cleaning process. In some cases, the deposition and etching processes may be performed using a plasma reaction. For a three-dimensional semiconductor device (e.g., V-NAND Flash memory), there is an increasing demand for a method capable of forming patterns with a high aspect, and a gas-pulsing etching process is studied to meet the demand. In addition, a reduction in size of patterns leads to an increase in the number of process steps.

SUMMARY

[0004] Some example embodiments of the inventive concepts provide a substrate treatment apparatus configured to supply an additional gas into an exhausting line and to control an internal pressure of a chamber.

[0005] Some example embodiments of the inventive concepts provide a substrate treatment apparatus including a diffusion part, allowing a control gas to be diffused when the control gas is supplied into the exhausting line through an injection unit.

[0006] According to some example embodiments of the inventive concepts, a substrate treatment apparatus may include a process chamber; a gas supply assembly; a gas exhaust assembly; an exhaust valve; a gas injector assembly; and a gas injection control device. The gas supply assembly may be configured to supply a first gas and a second gas into the process chamber such that the first gas is supplied into the process chamber at a uniform first flow rate, and the second gas is supplied into the process chamber at a second flow rate. The second flow rate may vary according to a first pulse wave. The first pulse wave may have a particular time period. The gas exhaust assembly may be configured to exhaust the first and second gases from the process chamber. The gas exhaust assembly may include an exhausting line coupled to the process chamber, the exhausting line being configured to discharge gas from the process chamber, and a pump coupled to the exhausting line, the pump being configured to induce gas flow from the process chamber through the exhausting line. The exhaust valve may be coupled to the exhausting line and may be configured to control a flow rate of gas into the exhausting line from the process chamber, the exhaust valve including a fixed opening extent. The gas injector assembly may be coupled to the exhausting line between the exhaust valve and the pump, the gas injector assembly being configured to supply a third gas into the exhausting line. The gas injection control device may be configured to measure an internal pressure of the process chamber, and control the injection unit to supply the third gas into the exhausting line at a third flow rate based on the measured internal pressure of the process chamber, the third flow rate varying according to a second pulse wave, the second pulse wave having the particular time period.

[0007] The gas injection control device may include a chamber pressure sensor configured to measure the internal pressure of the process chamber and a controller device configured to process the measured internal pressure of the process chamber to determine the third flow rate and control the injection unit to supply the third gas into the exhausting line according to the third flow rate.

[0008] The second pulse wave may be phase-shifted from the first pulse wave according to a phase difference, the phase difference being approximately one-half of the time period.

[0009] The second pulse wave may be phase-shifted from the first pulse wave by approximately 180 degrees.

[0010] The gas injection control device may be configured to control the third flow rate such that the internal pressure of the process chamber ranges from about 15 mTorr to about 25 mTorr.

[0011] The gas injector assembly may include a third gas reservoir configured to hold the third gas and a third gas supply line that couples the third gas reservoir to the exhausting line. The apparatus may further include a control valve coupled to the third gas supply line, the control valve being configured to control an opening extent of the third gas supply line. The gas injection control device may be configured to control the third gas reservoir and the control valve to adjustably control the third flow rate.

[0012] The first gas may include one of argon or helium. The second gas may include one or more fluorocarbons. The third gas may be a non-reactive gas including one of argon, nitrogen, or helium.

[0013] The apparatus may further include a diffuser between the exhausting line and the gas injector assembly. The diffuser may be configured to diffuse the third gas supplied into the exhausting line from the as injector assembly.

[0014] According to some example embodiments of the inventive concepts, a substrate treatment apparatus may include a process chamber, a gas supply assembly, a gas exhaust assembly, an exhaust valve, a gas injector assembly, and a diffuser. The gas supply assembly may be configured to supply a first gas and a second gas into the process chamber. The gas exhaust assembly may be configured to exhaust the first and second gases from the process chamber. The gas exhaust assembly may include an exhausting line coupled to the process chamber, the exhausting line being configured to discharge gas from the process chamber, and a pump coupled to the exhausting line, the pump being configured to induce gas flow from the process chamber through the exhausting line. The exhaust valve may be coupled to the exhausting line. The exhaust valve may be configured to control a flow rate of gas into the exhausting line from the process chamber, the exhaust valve including a fixed opening extent. The gas injector assembly may be coupled to the exhausting line between the exhaust valve and the pump. The gas injector assembly may be configured to supply a third gas into the exhausting line. The diffuser